Exhibit A
SCOPE OF WORK

TECHNICAL TASK LIST

Task #	CPR	Task Name
1	N/A	Administration
2		Climate Monitoring
3		Data Archive
4		New Climate Scenarios for California
5		Climate Change and Coastal Fog in California
6		Investigation of Potential Sources of Errors in Hydrologic Models
7		Climate Load Forecasting Scoping Study
8		Technology Transfer and Facilitating the Science-Practice Interaction

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Dan Cayan		
2-3	Dan Cayan	Desert Research Institute/U. of Nevada	
4	Dan Cayan	Santa Clara University	
5-7	Dan Cayan		
8	Dan Cayan	Susanne Moser Research and Consulting	

GLOSSARY

Specific terms and acronyms used throughout this work statement are defined as follows:

Acronym	Definition
AR5	Assessment Report 5
BCCA	Bias Correction Constructed Analogue
BCSD	Bias Correction/Spatial Downscaling
CalClim	California Climate Archive
CLM	Community Land Model
CPR	Critical Project Review
DRI	Desert Research Institute
Energy Commission	California Energy Commission
ENSO	El Niño/La Niña-Southern Oscillation
IPCC	Intergovernmental Panel on Climate Change
NOAH	National Centers for Environmental Prediction/Oregon State

Acronym	Definition
	University/Air Force/Hydrologic Research Lab Model
NWS	National Weather Service
PDO	Pacific Decadal Oscillation
PET	Potential Evapotranspiration
PIER	Public Interest Energy Research
ROMS	Regional Ocean Modeling System
RSM	Regional Spectral Model
SAC-SMA	Sacramento Soil Moisture Accounting model
SST	Sea Surface Temperature
UCC.1	Uniform Commercial Code (Financing Statement)
VIC	Variable Infiltration Capacity Model

Problem Statement

Climate change will impact every sector of the state economy and its natural resources. The energy sector could be affected in multiple ways ranging from increased electricity demand for cooling to reduced energy demand for residential heating. Energy infrastructure is also vulnerable to multiple climate-induced physical impacts such as sea level rise and extreme events. For example, an increased frequency and magnitude of forest fires would affect the electricity transmission and costal power plants may be affected by sea level rise.

National and international climate change research efforts are constantly producing new findings. In most cases, the national and international research products must be tailored for California to make them relevant to policy formulation in the State. For example, several research groups have started to release their global climate scenarios for the 21st century that have been developed using as input the new global emission scenarios developed for the next Intergovernmental Panel on Climate Change (IPCC) Assessment Report (AR5). These new global climate scenarios come from the new Earth System Models using higher spatial and temporal resolutions than those used for prior IPCC Assessments. However, the geographical resolution of the new Earth System Models are still too coarse to resolve important features in California and should not and cannot be used directly to develop adaptation plans at the local/regional levels.

Improved climate scenarios for California are a prerequisite to continue advancing climate change impacts and adaptation science in California, including impacts and adaptation assessments for the energy sector. There are several climate research issues of high relevance to the energy sector. This paragraph illustrates a few examples of these issues. It is unclear if coastal upwelling (rise of cold, often nutrient-rich waters from the ocean depths to the surface) will increase or decrease under a changing climate, with some observational studies suggesting a decrease in coastal fog and stratus (elevated fog) and others implying a cooling or very minor summer warming trend in areas near the coast. The actual development of coastal fog and stratus in the rest of this century will impact electricity demand for cooling in California. Climate impacts in California are also affected strongly by the hydrological conditions, including rain, snow, run-off, and soil moisture of the land surface. These conditions are closely

tied to water resources, including hydropower, and also modulate surface temperatures and thus influence the demand for electricity. However, hydrologic models used to estimate these impacts have limitations that may prove critical for impact assessments, such as the assumption that snow melting is a function of ambient air temperature only. This assumption works well for historical conditions, but since temperature is used as a proxy for solar radiation, which directly impacts snow melting, this simplification may not work well under future conditions because temperatures may go up with or without a concomitant change in solar radiation. The start and duration of the snow melting period is very important in estimation of potential impacts to hydropower generation.

Goals of the Agreement

The goal of this Agreement is to continue to develop policy-relevant climate information and learn about climate-related factors that can impact energy generation and consumption in the state of California.

Since 2003, the California Climate Change Center at the Scripps Institution of Oceanography has produced policy-relevant research products that have been extremely valuable in informing policy in California. A case in point, the 2006 and 2009 reports from the California Climate Action Team made use of the climate scenarios developed by the Center at Scripps. More recently, the Center made the case that reducing greenhouse gas emissions will not be enough to completely mitigate their influence on climate and that some impacts are unavoidable. This finding was a contributing factor to the Executive Order S-13-08 mandating the preparation of adaptation strategies for California under the leadership of the Natural Resources Agency.

Phase V of the activities of the Center at Scripps will continue supporting core research activities that will be used for future reports to the Governor and the Legislature and support adaptation planning by local, regional, and state entities.

This agreement "[will] advance energy science or technologies of value to California citizens..." (Public Resources Code 25620.(c)), and is part of a "full range of research, development, and demonstration activities that . . . are not adequately provided for by competitive and regulated markets (Public Resources Code 25620.1.(a)); and supports California's goal to develop regional climate models designed to allow strategic planning for water availability and related planning for electricity supply per the Integrated Energy Policy Report 2005.

This agreement also addresses Governor's Executive Order S-3-05 that mandates the preparation of biennial climate change impacts studies. The Energy Commission is the main source of this information, provided to the Governor and the Legislature via the Climate Change Action Team. Executive Order S-13-08 and the recently adopted 2009 California Climate Adaptation Strategy identify the Energy Commission's Public Interest Energy Research (PIER) Program as the main source of scientific information on climate change research in California that is needed to develop adaptation measures.

Objectives of the Agreement
The objectives of this Agreement are to:

- Investigate climate change-related factors that may impact energy generation and/or demand.
- Develop new climate scenarios for California.

TASK 1.0 ADMINISTRATION

MEETINGS

Task 1.1 Attend Kick-off Meeting

The goal of this task is to establish the lines of communication and procedures for implementing this Agreement.

The Contractor shall:

- Attend a "kick-off" meeting with the Commission Contract Manager, the Contracts Officer, and a representative of the Accounting Office. The Contractor shall bring their Project Manager, Contracts Administrator, Accounting Officer, and others designated by the Commission Contract Manager to this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the Commission Contract Manager will provide an agenda to all potential meeting participants.

  The administrative portion of the meeting shall include, but not be limited to, the following:
  - Terms and conditions of the Agreement
  - CPRs (Task 1.2)
  - Match fund documentation (Task 1.7)
  - Permit documentation (Task 1.8)

  The technical portion of the meeting shall include, but not be limited to, the following:
  - The Commission Contract Manager's expectations for accomplishing tasks described in the Scope of Work;
  - An updated Schedule of Deliverables
  - Progress Reports (Task 1.4)
  - Technical Deliverables (Task 1.5)
  - Final Report (Task 1.6)

The Commission Contract Manager shall designate the date and location of this meeting.

Contractor Deliverables:

- An Updated Schedule of Deliverables
- An Updated List of Match Funds
- An Updated List of Permits

Commission Contract Manager Deliverables:

- Final Report Instructions

Task 1.2 CPR Meetings

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and if it should, are there any modifications that need to be made to the tasks, deliverables, schedule or budget.

CPRs provide the opportunity for frank discussions between the Energy Commission and the Contractor. CPRs generally take place at key, predetermined points in the Agreement, as determined by the Commission Contract Manager and as shown in the Technical Task List above and in the Schedule of Deliverables. However, the Commission Contract Manager may schedule additional CPRs as necessary, and, if necessary, the budget will be reallocated to cover the additional costs borne by the Contractor, but the overall contract amount will not increase.

Participants include the Commission Contract Manager and the Contractor, and may include the Commission Contracts Officer, the PIER Program Team Lead, other Energy Commission staff and Management as well as other individuals selected by the Commission Contract Manager to provide support to the Energy Commission.

The Commission Contract Manager shall:

- Determine the location, date and time of each CPR meeting with the Contractor. These meetings generally take place at the Energy Commission, but they may take place at another location.
- Send the Contractor the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion on both match funding and permits.
- Conduct and make a record of each CPR meeting. One of the outcomes of this meeting will be a schedule for providing the written determination described below.
- Determine whether to continue the project, and if continuing, whether or not to modify the tasks, schedule, deliverables and budget for the remainder of the Agreement, including not proceeding with one or more tasks. If the Commission Contract Manager concludes that the project needs a formal amendment or that satisfactory progress is not being made and the project needs to be ended, these conclusions will be referred to the Commission's Research, Development and Demonstration Policy Committee for its concurrence.
- Provide the Contractor with a written determination in accordance with the schedule. The written response may include a requirement for the Contractor to revise one or more deliverable(s) that were included in the CPR.

The Contractor shall:

- Prepare a CPR Report for each CPR that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This

report shall be submitted along with any other deliverables identified in this Scope of Work. Submit these documents to the Commission Contract Manager and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Present the required information at each CPR meeting and participate in a discussion about the Agreement.

Contractor Deliverables:
- CPR Report(s)
- CPR deliverables identified in the Scope of Work

Commission Contract Manager Deliverables:
- Agenda and a List of Expected Participants
- Schedule for Written Determination
- Written Determination

Task 1.3 Final Meeting

The goal of this task is to closeout this Agreement.

The Contractor shall:
- Meet with the Energy Commission to present the findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement.

  This meeting will be attended by, at a minimum, the Contractor, the Commission Contracts Officer, and the Commission Contract Manager. The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be two separate meetings at the discretion of the Commission Contract Manager.

  The technical portion of the meeting shall present findings, conclusions, and recommended next steps (if any) for the Agreement. The Commission Contract Manager will determine the appropriate meeting participants.

  The administrative portion of the meeting shall be a discussion with the Commission Contract Manager and the Contracts Officer about the following Agreement closeout items:

  - What to do with any state-owned equipment (Options)
  - Need to file UCC.1 form re: Energy Commission's interest in patented technology
  - Energy Commission's request for specific "generated" data (not already provided in Agreement deliverables)
  - Need to document Contractor's disclosure of "subject inventions" developed under the Agreement
  - "Surviving" Agreement provisions, such as repayment provisions and

confidential deliverables
- Final invoicing and release of retention

- Prepare a schedule for completing the closeout activities for this Agreement.

Deliverables:
- Written documentation of meeting agreements and all pertinent information
- Schedule for completing closeout activities

REPORTING

See Exhibit D, Reports/Deliverables/Records.

Task 1.4 Quarterly Progress Reports
The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement.

The Contractor shall:
- Prepare progress reports which summarize all Agreement activities conducted by the Contractor for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to the Commission Contract Manager within 10 working days after the end of the reporting period. Attachment A-2, Progress Report Format, provides the recommended specifications.

Deliverables:
- Quarterly Progress Reports

Task 1.5 Test Plans, Technical Reports and Interim Deliverables

The goal of this task is to set forth the general requirements for submitting test plans, technical reports and other interim deliverables, unless described differently in the Technical Tasks. When creating these deliverables, the Contractor shall use and follow, unless otherwise instructed in writing by the Commission Contract Manager, the latest version of the PIER Style Manual published on the Energy Commission's web site:

http://www.energy.ca.gov/contracts/pier/contractors/index.html

The Contractor shall:
- Unless otherwise directed in this Scope of Work, submit a draft of each deliverable listed in the Technical Tasks to the Commission Contract Manager for review and comment in accordance with the approved Schedule of Deliverables. The Commission Contract Manager will provide written comments back to the Contractor on the draft deliverable within 10 working days of receipt. Once agreement has been reached on the draft, the Contractor shall submit the final deliverable to the

Commission Contract Manager. The Commission Contract Manager shall provide written approval of the final deliverable within 5 working days of receipt. Key elements from this deliverable shall be included in the Final Report for this project.

Task 1.6 Final Report

The goal of this task is to prepare a comprehensive written Final Report that describes the original purpose, approach, results and conclusions of the work done under this Agreement. The Commission Contract Manager will review and approve the Final Report. The Final Report must be completed on or before the termination date of the Agreement. When creating these deliverables, the Contractor shall use and follow, unless otherwise instructed in writing by the Commission Contract Manager, the latest version of the PIER Style Manual published on the Energy Commission's web site:

http://www.energy.ca.gov/contracts/pier/contractors/index.html

The Final Report shall be a public document. If the Contractor has obtained confidential status from the Energy Commission and will be preparing a confidential version of the Final Report as well, the Contractor shall perform the following subtasks for both the public and confidential versions of the Final Report.

Task 1.6.1 Final Report Outline

The Contractor shall:
- Prepare a draft outline of the Final Report.
- Submit the draft outline of Final Report to the Commission Contract Manager for review and approval. The Commission Contract Manager will provide written comments back to the Contractor on the draft outline within 10 working days of receipt. Once agreement has been reached on the draft, the Contractor shall submit the final outline to the Commission Contract Manager. The Commission Contract Manager shall provide written approval of the final outline within 5 working days of receipt.

Deliverables:
- Draft Outline of the Final Report
- Final Outline of the Final Report

Task 1.6.2 Final Report

The Contractor shall:
- Prepare the draft Final Report for this Agreement in accordance with the approved outline.
- Submit the draft Final Report to the Commission Contract Manager for review and comment. The Commission Contract Manager will provide written comments within 10 working days of receipt.

Once agreement on the draft Final Report has been reached, the Commission Contract Manager shall forward the electronic version of this report for Energy Commission internal approval. Once the approval is given, the Commission Contract Manager shall provide written approval to the Contractor within 5 working days.

- Submit one bound copy of the Final Report with the final invoice.

Deliverables:
- Draft Final Report
- Final Report

MATCH FUNDS, PERMITS, AND ELECTRONIC FILE FORMAT

Task 1.7 Identify and Obtain Matching Funds

The goal of this task is to ensure that the match funds planned for this Agreement are obtained for and applied to this Agreement during the term of this Agreement.

The costs to obtain and document match fund commitments are not reimbursable through this Agreement. While the PIER budget for this task will be zero dollars, the Contractor may utilize match funds for this task. Match funds shall be spent concurrently or in advance of PIER funds during the term of this Agreement. Match funds must be identified in writing, and the associated commitments obtained before the Contractor can incur any costs for which the Contractor will request reimbursement.

The Contractor shall:
- Prepare a letter documenting the match funding committed to this Agreement and submit it to the Commission Contract Manager at least 2 working days prior to the kick-off meeting:

    1. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state such in the letter.

    2. If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter:

        - A list of the match funds that identifies the:
            - Amount of each cash match fund, its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied.
            - Amount of each in-kind contribution, a description, documented market or book value, and its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or

real property, the Contractor shall identify its owner and provide a contact name, address and telephone number, and the address where the property is located.

- A copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured.

- Discuss match funds and the implications to the Agreement if they are significantly reduced or not obtained as committed, at the kick-off meeting. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide the appropriate information to the Commission Contract Manager if during the course of the Agreement additional match funds are received.
- Notify the Commission Contract Manager within 10 working days if during the course of the Agreement existing match funds are reduced. Reduction in match funds may trigger an additional CPR.

Deliverables:
- A letter regarding Match Funds or stating that no Match Funds are provided
- Letter(s) for New Match Funds
- A copy of each Match Fund commitment letter
- Letter that Match Funds were Reduced (if applicable)

Task 1.8 Identify and Obtain Required Permits

The goal of this task is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track.

Permit costs and the expenses associated with obtaining permits are reimbursable under this Agreement. Permits must be identified in writing before the Contractor can incur any costs related to the use of the permit(s) for which the Contractor will request reimbursement.

The Contractor shall:
- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the Commission Contract Manager at least 2 working days prior to the kick-off meeting:

    1. If there are no permits required at the start of this Agreement, then state such in the letter.

    2. If it is known at the beginning of the Agreement that permits will be required during the course of the Agreement, provide in the letter:

        - A list of the permits that identifies the:

        - Type of permit
        - Name, address and telephone number of the permitting jurisdictions or lead agencies
    - Schedule the Contractor will follow in applying for and obtaining these permits.

- The list of permits and the schedule for obtaining them will be discussed at the kick-off meeting, and a timetable for submitting the updated list, schedule and the copies of the permits will be developed. The implications to the Agreement if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in the progress reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, then provide the appropriate information on each permit and an updated schedule to the Commission Contract Manager.
- As permits are obtained, send a copy of each approved permit to the Commission Contract Manager.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the Commission Contract Manager within 5 working days. Either of these events may trigger an additional CPR.

Deliverables:
- A letter documenting the Permits or stating that no Permits are required
- Updated list of Permits as they change during the Term of the Agreement
- Updated schedule for acquiring Permits as it changes during the Term of the Agreement
- A copy of each approved Permit

Task 1.9 Electronic File Format

The goal of this task is to unify the formats of electronic data and documents provided to the Energy Commission as contract deliverables. Another goal is to establish the computer platforms, operating systems and software that will be required to review and approve all software deliverables.

The Contractor shall:
- Deliver documents to the Commission Contract Manager in the following formats:
    - Data sets shall be in Microsoft (MS) Access or MS Excel file format.
    - PC-based text documents shall be in MS Word file format.
    - Documents intended for public distribution shall be in PDF file format, with the native file format provided as well.
    - Project management documents shall be in MS Project file format.

- Request exemptions to the electronic file format in writing at least 90 days before the deliverable is submitted.

Deliverables:

- A letter requesting exemption from the Electronic File Format (if applicable)

TECHNICAL TASKS

The Contractor shall prepare all deliverables in accordance with the requirements in Task 1.5. Deliverables not requiring a draft version are indicated by marking "(no draft)" after the deliverable name.

Task 2 Climate Monitoring

The goal of this task is to improve the observation of climate change in California by adding snow, soil moisture, and radiation sensors to existing meteorological stations installed with prior PIER funding. These sensors will provide fundamental measurements that will complement the existing meteorological and hydrological observations being collected along representative mountain and riverine transects. Mountain snowpack is a crucial, natural water reservoir for California. An ample spring snowpack is not only an important water resource but it also provides hydropower and is thought to help retard large summer forest fires. Solar radiation is a key driver of spring snowmelt and is also a fundamental component that affects natural ecosystems and agriculture. Soil moisture is tied to snow melt, runoff and ecosystem status. Adding radiation, snow, and soil moisture sensors to stations along our mountain and river transects will provide an important element in verifying and understanding hydrological model performance, and more generally to interpret and predict effects of climate variation and change on processes that drive water and energy resources in the state.

The Contractor shall:

- Install new acoustic snow sensors at Tioga Road weather stations, including Smokey Jack and Quarry, to provide more complete survey of snowfall along the west slope of the Sierra Nevada.
- Install incoming and outgoing radiation sensors at Smokey Jack and Hodgdon Meadows stations.
- Augment selected stations with improved communications (wireless transfer of data).
- Install soil monitoring sensors at selected climate stations established by the Desert Research Institute (DRI) group.
- Maintain existing Yosemite, White Mountains, San Diego/Riverside County, and other California stations by periodic visits to ensure their structural integrity and the proper functioning of equipment.
- Prepare a brief technical memorandum entitled "Enhanced Climate Monitoring Supported by the California Climate Change Center" documenting the installation and operation of these instruments.

Deliverables:

- Technical memorandum: Enhanced Climate Monitoring Supported by the California Climate Change Center (no draft)

Task 3 Data Archive

The goal of this task is to continue supporting the California Climate Change Center's archive of historical climate data for California, making the datasets and an on-going set of climate trend analyses available to other researchers and interested decision makers.

The Contractor shall:

- Analyze, in coordination with Scripps California Climate Change Center, data from Sierra Nevada weather and climate stations (sponsored by the California Cooperative Snow Survey, and by PIER) for trend and variability information. There are a number of such stations and they have never been examined in this manner. From recent experience, few of these stations have records that have been "cleaned," so this will require development of quality control algorithms to be applied to the historical observations.
- Develop climate status indicators for California and provision of time series of their values to *Indicators of Climate Change in California* using the website known as the California Climate Tracker (http://www.wrcc.dri.edu/monitor/cal-mon/index.html).
- Develop a new Google-based graphical interface to the California Climate Archive (CalClim - http://www.calclim.dri.edu/) and incorporate Scripps stations into this interface.
- As needed, provide data and/or products, such as the historical climate data and the climate trend analyses, to the PIER Cal-Adapt effort with the understanding that proper credit will be given to the original authors.
- Maintain and update the CalClim and the California Climate Tracker webpages with new data and analyses as they become available.
- Submit copies of updated web pages to the Commission Contract Manager.

Deliverables:

- Copies of updated web pages (no draft)

Task 4 New Climate Scenarios for California

The overall goal of this task is to improve the models used to downscale the results from the new Earth System Models to generate climate scenarios for California at adequate geographical and temporal resolution for both research and long-term planning in California.

Sub-task 4.1 Coupling a Regional Ocean Model with an Atmospheric Regional Climate Model

The goal of this sub-task is to couple the Regional Spectral Model (RSM) with the regional ocean modeling system (ROMS) to simulate the close interaction between the

ocean and land areas, which has not been simulated in prior PIER supported efforts. There is an obvious impact of the Pacific Ocean upon the climate along the California coast and a number of scientists have argued that some of the manifestations of these interactions (e.g., coastal fog in the summer) would change with a changing climate.

The Contractor shall:

- Produce two sets of runs, at 10km horizontal resolution, over the greater-California domain and analyze the data. The first set shall be a reanalysis run of approximately 10 years from a recent observed period. This run will be made for both the uncoupled atmosphere and the coupled atmosphere-ocean. The second set shall be a climate simulation using the coupled regional model, nominally guided by an Earth System Model having both a 10 year historical control period plus a projected 10 year mid- to end of century climate change period.
- Investigate and implement “bias” correction techniques for the freely running Earth System Model before downscaling the data using the coupled regional ocean/atmosphere model.
- Prepare a report entitled “Investigation of the Utility of a Coupled Regional Ocean/Atmosphere Model to Produce Climate Scenarios for California” that summarizes the activities undertaken under this task.

Deliverables:

- Report: Investigation of the Utility of a Coupled Regional Ocean/Atmosphere Model to Produce Climate Scenarios for California

Sub-task 4.2 New Statistical Downscaling Tools for California

The goal of this sub-task is to substantially enhance the statistical downscaling models that Scripps and partners have developed for the PIER program, which has been used to produce climate scenarios for California. To the degree possible, this work will be coordinated with the U.S. National Climate Assessment, which has recently begun and is scheduled for release in the summer of 2013.

The Contractor shall:

- Introduce new variables (wind, solar radiation, relative humidity) into the statistical downscaling model Bias Correction Constructed Analogue (BCCA) and produce a new hybrid statistical/card10 downscaling of solar radiation and other variables associated with crucial climate processes such as evapotranspiration. California Reanalysis Downscaling at 10km (card10) are modeling outputs produced by Scripps under a prior PIER project.
- Downscale new model simulations, from IPCC AR5 efforts downscaled as in the past using the Bias Correction/Spatial Downscaling (BCSD), BCCA, and the enhanced BCCA downscaling models.
- Use a hydrologic model, such as the VIC, to estimate hydrologic impacts.
- Produce probabilistic climate projections for California using multiple (at least two) emissions scenarios.

- Produce a report entitled “New “Probabilistic” Climate Scenarios for California” that summarizes the activities undertaken under this task.

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Deliverable:

- Report: New “Probabilistic” Climate Scenarios for California

Task 5 Climate Change and Coastal Fog in California

The goal of this task is to investigate how climate change may affect coastal fog and stratus (above-ground fog) in California. The presence of fog and stratus is a major factor in dampening atmospheric temperature and increasing humidity along the California coast, as well as producing unique ecosystems and climate zones in coastal areas and moderating the cooling demand in major coastal cities.

Recent observational studies by Johnstone and Dawson (2010 PNAS) and Iacobellis et al. (2010 California Air Resources Board Report) present tentative evidence of diminished coastal stratus. These observational results are in sharp contrast with previous indirect observational and modeling studies that suggest that climate change would disproportionately warm the interior region of California, resulting in an enhanced onshore flow and then an increase in coastal fog and upwelling. To help resolve these differences, more in-depth studies are needed.

The Contractor shall:

- Employ a set of observational data, including cloud cover, vertical temperature inversions, sea surface temperature (SST), and atmospheric circulation, along with surface air temperature along the California region, to establish the relationships between cloud, circulation, SST and daily maximum and daily minimum temperature at time scales ranging from synoptic to decadal. The Contractor will seek to determine the spatial influence of cloud cover and SST on surface temperature, including the strength of the influence, the season in which it operates, and how far inland it extends.
- Estimate if the low frequency variations (features that change slowly with time) of cloud cover and associated measures are primarily due to natural variability (e.g. Pacific Decadal Oscillation (PDO)) or are perhaps a symptom of global climate change and thus may be the early expression of a long term change.
- Investigate the relationships that emerge between regional-to-large scale atmospheric circulation and SST vs. coastal cloud cover as possible predictors to employ in the statistical downscaling scheme for coastal cloudiness. Because there is a significant link between coastal cloud cover and summer air temperature, this will have an obvious implication upon understanding climate-driven electrical energy demand.
- Produce a report entitled “Climate Change and Coastal Fog and Stratus in California” that summarizes the activities undertaken under this task.

Deliverable:

- Report: Climate Change and Coastal Fog and Stratus in California

Task 6 Investigation of Potential Sources of Errors in Hydrologic Models

Climate impacts in California are affected strongly by the hydrological status, including rain, snow, run-off, and soil moisture of the land surface. These conditions are closely tied to water resources, including hydropower, and also modulate surface temperatures and thus influence the demand for electricity. The goal of this task is to perform an investigation of potential sources of errors in hydrological models commonly used for climate change impacts studies. For example, the VIC model assumes that snow melting is a function of ambient air temperature. This assumption works well for historical conditions, but since temperature is used as a proxy for solar radiation, this simplification may not work well under future conditions because temperatures may go up with or without a concomitant change in solar radiation.

The Contractor shall:

- Investigate the use of solar radiation and/or other related variables, which directly affect snow melting, as the driver for the estimation of snow melting in the VIC model and potentially other hydrological models.
- Develop new methods to simulate snow melt that could be used in hydrological models using a 12 year record of observed cloud and some observed surface data, and also using several decades of high resolution (10km) Card10 reanalysis simulated observations.
- Test the ability of these new approaches to predict snow melt using observed snow and streamflow data from the California Sierra Nevada region.
- Analyze the historical record using Card10 10km reanalysis plus a set of dynamical model simulations for 2064-2074 from RSM to investigate what drives potential evapotranspiration (PET). This is an important issue because PET determines the loss of water to the atmosphere and will presumably increase as climate warms. Increased evaporation would likely provoke increased demand for water in agricultural and residential outside-use settings, which could drive increased electrical demand for processing and pumping.
- Perform an analysis of the conventional scheme that uses air temperature to drive PET in comparison to a Penman formulation using wind, humidity and radiation from the dynamical model output.
- Explore differences in estimated PET over the California region using multiple hydrological models (VIC, National Centers for Environmental Prediction/Oregon State model (NOAH), Sacramento Soil Moisture Accounting model [SAC-SMA], and Community Land Model (CLM)). These experiments will be conducted over the historical climate period (1950-2004) and also over the projected climate period using downscaled Earth System simulations as described in prior tasks.
- Prepare a report entitled “Investigation of Potential Sources of Errors in Hydrologic Models Used for Climate Change Studies” that summarizes the activities undertaken under this task.

Deliverables:

- Report: Investigation of Potential Sources of Errors in Hydrologic Models Used for Climate Change Studies

Task 7 Climate Load Forecasting Scoping Study

The goal of this task is to test the usability of climate downscaling techniques developed for PIER for near-term and seasonal forecasts and to test this usability working with the energy forecasting group at the Energy Commission. Another goal of this task is to test how using probabilistic forecasts could enhance adaptation to current levels of climate variability as a tool to learn how to adapt to increased levels of variability expected under climate change.

The Contractor shall:

- Perform an in-depth study of the weather and climate anomaly (departures from average conditions) patterns associated with peak electricity load conditions (regional and statewide) during historical summer events. This will include a study of the time-evolving pattern(s) that set these up.
- Prepare a draft and final report entitled "Weather and Climate Conditions Associated with Peak Electricity Load in California."
- Analyze the historical climate data and projections for a better understanding of climate change's impacts upon temperature changes experienced in California. For example, the general understanding is that minimum daily temperatures are increasing more rapidly than maximum daily temperatures. It is not clear whether these increases vary seasonally, whether the minimum temperature increases are experienced proportionally across the twelve months of the year, and whether certain months or seasons experience greater variability from the experienced norm.
- Explore the use of probabilistic seasonal (six months before the summer) climate forecasts informed by the status of the El Niño/La Niña-Southern Oscillation (ENSO) and persistence of the PDO. The Energy Commission's Demand Analysis Office could use this information in its summer outlook reports. Currently, these outlooks assume the continuation of the past sixty years of weather history.
- Explore the use of probabilistic climate projections 10-12 years ahead, downscaling the upcoming Coupled Model Inter-comparison Project version 5 efforts that will include a strong component where modeling centers around the world will initialize their forecast models with current conditions, then generate 10-year climate outlooks. This information could be used for the Energy Commission's long-term energy demand forecasts.
- Prepare a report entitled "Exploratory Study of Probability Near and Seasonal Forecasts for Electricity Demand and Generation Applications in California" that summarizes the activities undertaken under this task.
- Explore the use of Delta Breeze probabilistic forecasting. Scripps Institution of Oceanography has done work on this in the past under a National Oceanic and Atmospheric Administration funded program. The Contractor will revisit the statistical forecast developed for that work to compare it to current weather forecasts. The delta breeze forecast as originally developed could be used in tandem with the then-

current national weather service (NWS) forecasts, supplanting the NWS forecast when conditions are met, and falling back on the NWS forecast when the identified precursors for an accurate statistical forecast were not met. The contractor will evaluate if this can still be done with the newest NWS forecast system, which has been upgraded since the delta breeze forecast was developed.
- Prepare a report entitled “Probabilistic Forecasting of the Delta Breeze” that summarizes the activities undertaken under this task.

Deliverables:
- Report: Weather and Climate Conditions Associated with Peak Electricity Load in California
- Report: Exploratory Study of Probability Near and Seasonal Forecasts for Electricity Demand and Generation Applications in California
- Report: Probabilistic Forecasting of the Delta Breeze

Task 8 Technology Transfer and Facilitating the Science-Practice Interaction

The goal of this task is to facilitate the transfer of information and new knowledge that the Contractor will generate under this Interagency Agreement. With the adoption of an Executive Order requiring the preparation and implementation of adaptation plans by state agencies in California and by the initiative of local and regional agencies, the demand for the products produced by the Contractor has increased by an order of magnitude. A second goal of this task is to develop a long-term plan on how this improved exchange between information needs and products between users and producers should be implemented.

The Contractor shall:
- Actively collaborate in the activities of the Cal-Adapt project (500-10-007) funded by PIER. Cal-Adapt is a collaborative project with Google® being executed by UC Berkeley to make data and climate research products available to the users in an accessible format.
- Present project results at the annual PIER Climate Change Conferences.
- Prepare a long-term plan on how to improve the link between researchers and technical users representing local, regional, and state and private entities in need of climate change information.
- Actively participate in committees formed by the Commission Contract Manager designed to coordinate biennial climate science assessments.

Deliverables:
- Plan: How to improve the link between researchers and users at the California Climate Change Center at Scripps
- Copy of PowerPoint or Adobe Acrobat files (no draft)